

### **REMARKS**

Applicants request reconsideration of the application as amended. Claims 37-52 are pending. Claims 37, 40 and 42 are amended for form and clarity. Claims 1-36 were previously canceled.

#### **Interview held February 4, 2008**

Applicants thank Examiner Hoffman for extending the courtesy of an in person interview with their undersigned representative on February 4, 2008. Claims 37, 39 and 40 and the scope and content of the Hawtof and Takahashi references were discussed.

#### **Claim Rejections - 35 U.S.C. §103**

##### ***Rejection of Claims 37, 38 and 41 Based on Hawtof and Takahashi***

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Applicants respectfully request reconsideration and withdrawal of the rejection of claims 37, 38 and 41 under 35 U.S.C. §103(a) as being unpatentable over Hawtof (US 6,565,823) in view of Takahashi (US 4,388,098).

Claim 37 is directed to a method for forming multicomponent glass particles in a flame and spraying the glass particles to a target. This method includes *inter alia* the following steps (emphasis added):

introducing a first glass component through a gas tube through the nozzle to the flame such that the first glass component reacts in the flame to form first oxide particles, wherein the first glass component consists of a gaseous or vaporous substance;

introducing a second glass component through a liquid tube separate from the gas tube through the nozzle to a vicinity of the flame, wherein the second glass component comprises a liquid solution containing a rare earth metal;

introducing an atomizing gas through the nozzle to the vicinity of the flame, and atomizing the second glass component with the atomizing gas in the vicinity of the flame so as to form second oxide particles in the flame; and

wherein the first oxide particles and the second oxide particles combine with each other in the flame so as to form multicomponent glass particles comprising the rare earth metal.

Thus, in claim 37, a first glass component is introduced to the flame in gas or vapor form in a gas tube, and a second glass component, including a rare earth metal, is introduced by a separate liquid tube and is then atomized by the atomizing gas in the vicinity of the flame. There are two separate tubes, meaning that there are two separate “feedstocks” – the first glass component and the second glass component, which are introduced through these different tubes that emerge from different orifices in the nozzle that come together at the flame. While claim 37 does not use the term “feedstock”, claim 37 certainly makes clear that there are two separate tubes, and persons of skill in the art would readily appreciate that these two separate tubes introduce the two separate glass feedstocks.

The separate glass feedstocks are important to the applicants’ invention. When making their invention, the applicants observed that their first glass component, usually  $\text{SiCl}_4$ , tended to react more slowly with oxygen than did rare earth metals. As a consequence, dopant particles would accumulate into the core of multicomponent glass particles, while silicon oxide particles placed themselves on the outside (or formed a clad layer over the dopant particles). In the claimed invention, applicants produce more homogeneous multicomponent glass particles by atomizing the liquid glass component that incorporates a dopant component in the vicinity of the flame, in combination with introducing a separate gaseous glass component to the flame. There is better mixing in the flame in this flame hydrolysis method. This prevents sequential deposits of different components.

Referring to FIG. 1 in Hawtof and the accompanying text, Hawtof discloses a method for forming fused silica glass. A liquid reactant (halide-free silicon-containing compound, e.g., siloxane feedstock) is delivered to a combustion burner 10. A dopant compound, which may be a metal oxide of a rare earth metal (Col. 7, lines 3-6), optionally is added to the liquid reactant either in the liquid feed tank 11 or at the liquid injector 15. The liquid reactant is atomized as it is introduced to the flame at the burner. Referring to FIG. 4 showing a preferred embodiment in Hawtof, an airblast atomizer directs high velocity inert gas, such as nitrogen, into the liquid reactant feedstock to produce the finely atomized liquid reactant particles that are introduced to the flame.

Hawtof does not carry out the method claimed in claim 37 because Hawtof does not introduce a first glass component in a gaseous or vaporous substance in a gas tube that is separate from a liquid tube through which a second glass component is introduced, where the second glass component is an atomized liquid solution containing a rare earth metal. Hawtof introduces *only the one atomized liquid stream* that optionally may contain a rare earth metal oxide through one atomizer or liquid injector tube.

Applicants respectfully disagree with the Examiner's expansive reading of Hawtof. Hawtof at all times directs skilled persons to introduce the siloxane feedstock *in liquid form*. That liquid may be atomized, but it is not intended to be in vapor form. Hawtof hedges his bets by noting that the "liquid" siloxane feedstock could include a small portion (unintended) of vapor as delivered to the burner combustion site. Skilled persons reading the complete Hawtof disclosure in context would understand that Hawtof directs them to use a siloxane feedstock in liquid form, not vapor form. Moreover, Hawtof does not direct use of two glass feedstocks -- a separate glass feedstock in liquid form with a rare earth metal and a separate glass feedstock in vapor form, as is required in pending claim 37. Hawtof has only the one liquid feedstock, which is directed to the flame through liquid injector 15 (FIG. 1) or atomizer 31 (FIG. 2) or atomizer 41 (FIG. 4). No separate vapor feedstock tube to the burner flame is shown. As such, even if the unintended vapor is present with the liquid siloxane in Hawtof, the combination passes

through an atomizer and is atomized. There is no component that is introduced separately to the flame as gas or vapor.

Applicants submit that the Examiner's interpretation of Col. 7, lines 36 to 44 of Hawtof is objectively unreasonable. At Col. 7, lines 36 to 44, Hawtof states:

We generally refer in the discussion to the reactant as being in "liquid" form. What we mean by that expression is that the reactant is in substantially liquid state. Some small portion of the reactant may be in vapor form, particularly where preheater 14 is employed, or where a nitrogen blanket over the liquid is employed. A small portion of the reactant can be in vapor form as delivered to the combustion site without adversely affecting the operation of the invention.

By this passage, Hawtof does not teach or encourage a skilled person to introduce two glass feedstocks to a burner, with one in liquid form and one in vapor form. Hawtof repeatedly notes that vapor feedstock introduction is to be avoided, and only teaches introducing a single liquid feedstock. FIGs. 1, 2, 3 and 4 of Hawtof show a single liquid siloxane feedstock introduced through one passage to a flame (e.g., injector 15 in FIG. 1 – which is syringe with fine needle, or atomizer 41 in FIG. 4).

In the Background section of the Hawtof patent, Hawtof identifies the problems associated with prior processes using "vaporous reactants". The feedstock solutions with high vapor pressures that made them "vaporous reactants" also had drawbacks -- detrimental by-products were formed, such as hydrochloric acid, and particulate pollutants were generated. (Col. 1, line 16 to Col. 2, line 10). Hawtof further notes that use of "vaporous reactants" leads to imperfections and unusable end products:

Applicants have found that, in the course of delivering a vaporized polyalkylsiloxane feedstock to the burner, high molecular weight species can be deposited as a gel in the line carrying the vaporous reactants to the

burner or within the burner itself. This leads to a reduction in the deposition rate of the soot preform that is subsequently consolidated to a blank from which an optical waveguide fiber is drawn. It also leads to imperfections in the blank that will produce defective or unusable optical waveguide fiber from the affected portions of the blank (Col. 4, lines 21 to 30).

Hawtof wished to avoid these drawbacks of vaporous reactants, and taught to inhibit vapor (Col. 6, lines 12 to 22):

The applicants have now discovered that the above-described problem is inhibited by delivering the siloxane feedstock in liquid form to the conversion site during the silica manufacturing process. By delivering the siloxane feedstock as a liquid instead of as a vapor, gelling of the siloxane feedstock is prevented in that exposure of the siloxane feedstock to the high temperature environments of a vaporizer and vapor delivery system are avoided. This improves the yield and quality of the fused silica produced and also reduces the maintenance requirements of the production system.

Thus, when confronted with these teachings in Hawtof, persons of ordinary skill in the art would not have been led to introduce a separate vapor or gas glass feedstock to a burner. Quite to the contrary, Hawtof teaches the skilled person to use only a single liquid glass feedstock, and identifies the many problems that Hawtof indicated can be avoided as compared with systems that used vapor feedstocks.

Takahashi does not fill this significant gap in the disclosure of Hawtof. Referring to FIGs. 3 and 4 and the accompanying text of Takahashi, a multi-conduit burner 31 introduces a gaseous glass raw material (such as  $\text{SiCl}_4$  carried by argon gas) through one conduit, and a nebulized metal salt solution through another conduit, as well as fuel (e.g. hydrogen) and oxygen gases through other conduits. Takahashi does not combine a

separate gas or vapor glass feedstock with a liquid glass component feedstock that includes a rare earth metal. Takahashi has a separate dopant solution devoid of glass component.

Persons of skill would not be disposed to combine Hawtof and Takahashi, because these two references seek to solve the problem of creating multicomponent glass particles in different ways. Takahashi represents a “vaporous reactants” type flame hydrolysis system that caused the drawbacks identified by Hawtof. Hawtof expressly seeks an entirely liquid feedstock system and Takahashi uses a gaseous or vaporous feedstock system. Takahashi atomizes or nebulizes a dopant solution, but such solution is not a glass component solution.

In addition, Takahashi starts with glass raw material that includes halide, such as  $\text{SiCl}_4$ ,  $\text{GeCl}_4$ ,  $\text{POCl}_3$  and  $\text{BBr}_3$ . Hawtof expressly avoids halide containing glass materials, preferring siloxanes, because Hawtof wants to avoid forming  $\text{HCl}$  (see, e.g., Hawtof at Col. 1, line 65 to Col. 2, line 22). Thus one skilled in the art would not readily combine these references that start with different raw materials and feed these different raw materials to a flame in different forms.

Still further, there would be no reasonable expectation of success from combining the disclosures of Hawtof and Takahashi as suggested by the Examiner. Hawtof states that “... burner 40 incorporates within its structure atomizer 41, which injects very finely atomized liquid reactant particles into flame 23.” *Hawtof*, Col. 8, lines 21-24. Hawtof explains that the liquid reactant might contain a small portion of vapor because the liquid feedstock has been vaporized due to heating or other reasons. Unlike the claimed invention, in Hawtof the vaporized portion and the liquid portion are introduced in the flame through the same channel, and as a result it is not possible to adjust the liquid and vapor portions separately, therefore making it impossible to find a workable temperature for the process. Furthermore, in Hawtof, both the vapor portion and the liquid portion are atomized when they exit the channel, whereas in the inventive process, only the liquid component is atomized. Based on these discrepancies between Hawtof and the claimed

invention, one would not expect to have success in combining the Hawtof and Takahashi references to arrive at the claimed process.

Claims 38 to 41 depend from claim 37, and are patentable for the same reasons claim 37 is patentable. For at least the above reasons, claims 37 to 41 are allowable over the combination of Hawtof and Takahashi.

### **Rejection of Claims 39 and 40 Based on Hawtof, Takahashi and Ainslie**

Applicant respectfully requests reconsideration and withdrawal of the rejection of claims 39 and 40 under 35 U.S.C. §103(a) as being unpatentable over Hawtof and Takahashi, as applied to claims 37 and 38, and further in view of Ainslie (US 4923,279).

Claims 39 and 40 depend from claim 37. Claims 39 and 40 are directed to specific embodiments in which the first glass component is silicon or germanium tetrachloride and the second glass component contains erbium nitrate, water or alcohol and aluminum. The first glass component thus is a “halide-containing” glass component.

Hawtof and Takahashi fail to render the method of claim 37 obvious for the reasons provided above. In addition, Hawtof specifically directs skilled persons away from using halide-containing silicon-containing compounds, such as silicon tetrachloride. (Col. 1, lines 60-64). These compounds produce undesirable hydrochloric acid by-product (Col. 1, line 65 to Col. 2, line 6). Hawtof expressly prefers “halide-free, silicon containing compounds”, such as siloxanes (Col. 2, lines 34-35; Col. 6, lines 57-65). In claims 39 and 40, the first glass component is expressly a substance that Hawtof teaches to avoid (a chloride). This is another reason that claims 39 and 40 distinguish over the attempted combination of Hawtof and Takahashi.

Ainslie does not supply the elements and motivation missing from Hawtof and Takahashi. First, Ainslie does not teach that problems Hawtof associated with halide-containing glass components can be overcome in a flame hydrolysis method. Ainslie

does not concern flame hydrolysis at all. Ainslie does not use a concentric nozzle burner that introduces separate glass components through separate tubes in atomized and gaseous or vaporous forms to a flame. Instead, Ainslie uses an inside deposition process called modified chemical vapor deposition (MCVD). With MCVD, layers of glass are deposited inside a tube, while the tube is heated from the outside. There is no mixing within a flame, and the feed gases are not introduced through a nozzle to a flame.

Ainslie expressly wants to have glass fibers with an inner core that includes dopant material surrounded by a cladding of different composition. Ainslie is not looking to make a homogeneous multicomponent glass particle, as is the aim of the methods claimed in claims 39 and 40. Ainslie "requires a high concentration of dopant at the axis" of the optical fiber (Col. 3, lines 8-9). To achieve this high concentration of dopant at the axis or core, Ainslie first uses MCVD to create various glass layers inside a tube. Then, the last porous glass layer formed by MCVD on the inside of the tube is doped with a rare earth metal (such as Er) by immersing the tube with the porous glass layer in a rare earth solution (containing  $\text{Al}(\text{NO}_3)_3$  and  $\text{ErCl}_3$ ) for one hour, after which the doped material is separately heated to evaporate the solvent.

Skilled persons would not be disposed to combine Ainslie's teachings -- concerning rare earth metal doping (using erbium chloride -- not erbium nitrate) by soaking the porous glass in a liquid solution after MCVD -- with the gas burner flame glass particle methods of Hawtof and Takahashi. The MCVD technique is completely different and has nothing to do with methods for spraying glass particles to a target. Applicants discovered specific methods for forming homogeneous multicomponent glass particles by spraying the glass particles to a target. In the claimed methods, the doping occurs as the components are reacted in the flame. There is no soaking solution or soaking time. A reference that concerns doping by soaking cannot translate to a method where doping occurs in a flame reaction. The Examiner could find no teaching of erbium nitrate as a doping material in Hawtof and Takahashi. And the Examiner cannot properly



pick and choose disparate teachings from a separate unrelated reference like Ainslie without regard to whether skilled persons would be motivated to combine such teachings.

Ainslie shows that erbium chloride can be doped into SiO<sub>2</sub> formed by an MCVD process using SiCl<sub>4</sub> and other glass components by an immersion method. Ainslie does not use a flame method. So, Ainslie does not teach or suggest anything with respect to whether flame sprayed glass particles can be doped with erbium or other rare earth metals. The relevant inquiry is not only whether a skilled artisan would gather from Ainslie that the particular rare earth metals would be beneficial in resultant glass fibers, as the Examiner has asserted, but also whether a skilled artisan having read Ainslie would have gathered that one could successfully apply those rare earth metals in a flame mixing method as claimed in claims 39 and 40. Ainslie provides no suggestion to apply the particular rare earth metals in such claimed methods. These methods patentably distinguish from Hawtof, Takahashi and Ainslie.

Still further, applicants have submitted evidence (in the 37 C.F.R. §1.132 Declaration of Simo Tammela dated May 4, 2005 - filed in the Amendment in response to the Office Action dated April 21, 2005) that shows erbium doped glass fibers made by the claimed method have improvement in peak absorption and cut off wavelength over erbium doped glass fibers made using an MCVD method. This evidence rebuts any assertion that erbium doping by an MCVD method could be directly translated to a flame hydrolysis method such as claimed by the present applicants. Erbium doping efficiency and homogeneity is different in these methods.

For all of the above reasons, claims 39 and 40 are allowable over the combination of Hawtof, Takahashi and Ainslie.

***Rejection of claims 37-45 based on Randall, Hawtof, Ainslie and Takahashi***

Applicants respectfully request reconsideration and withdrawal of the rejection of claims 37-45 under 35 U.S.C. §103(a) as being unpatentable over Randall (US 3883336) in view of Hawtof, Ainslie and Takahashi.

Independent claims 37, 42 and 44 all require that fuel gas, a first glass component in gas or vapor form, a second glass component in liquid form that contains a rare earth metal, and an atomizing gas are all introduced through the same multi-conduit nozzle to a flame. In contrast, Randall shows a separate nebulizer directing a solution of dopant to the flame of a flame hydrolysis system burner. The separate nebulizer does not pass the liquid and atomizing gas through the same nozzle that directs the fuel gas and first glass component ( $\text{SiCl}_4$  in the Figure in Randall) to the flame. Nor does Randall include a second glass component that incorporates a rare earth metal.

In contrast to the claimed invention as set forth in claims 37-45, Randall does not:

- a) disclose introducing a second glass component through a liquid tube through the nozzle to the vicinity of the flame;
- b) mention rare earth metals and a solution containing a rare earth ion, water or alcohol, and a form of aluminum which is soluble in water or alcohol (claim 42);
- c) disclose introducing an atomizing gas through the nozzle to the vicinity of the flame;
- d) disclose atomizing the second glass component in the vicinity of the flame; or
- e) disclose producing glass particles containing a rare earth metal.

Looking to the secondary references that have been cited, only Takahashi concerns a flame hydrolysis method for making glass particles. However, Takahashi does not fill the gaps in Randall. Referring to FIGs. 3 and 4 and the accompanying text of Takahashi, a multi-conduit burner 31 introduces a gaseous glass raw material (such as  $\text{SiCl}_4$  carried by argon gas) through one conduit, and a nebulized metal salt solution through another conduit, as well as fuel (e.g. hydrogen) and oxygen gases through other conduits. Takahashi does not combine a separate gas or vapor glass feedstock with a separate liquid glass component feedstock that includes a rare earth metal. Takahashi has a separate dopant solution devoid of glass component.

As discussed above, applicants respectfully disagree that the disparate teachings of Hawtof and Ainslie properly are combined with teachings for flame hydrolysis methods, such as Randall and/or Takahashi. Randall and Takahashi start with halide-containing glass components, which Hawtof expressly seeks to avoid. Randall and Takahashi use “vaporous reactants”, where Hawtof directs use of siloxane in liquid feedstock form. Because siloxane behaves differently than silicon tetrachloride, one of ordinary skill in the art would not seek to combine Hawtof with Randall or Takahashi to arrive at the claimed method.

With respect to pending claim 44, Hawtof also fails to disclose delivering the first and second glass components (as interpreted by the Examiner) through separate tubes within a single multi-conduit nozzle. Therefore, combining the disclosures of Hawtof and Randall does not result in a teaching of delivering first and second glass components through separate tubes, as presently claimed.

Moreover, as discussed above, Ainslie represents an entirely different glass forming technology – MCVD, which is not based on flame hydrolysis and does not direct glass components and atomizing gases through a nozzle to a flame. Ainslie shows that erbium chloride (not erbium nitrate) can be doped into  $\text{SiO}_2$  formed by an MCVD process using  $\text{SiCl}_4$  and other glass components that includes immersing the porous glass in a solution that contains the erbium chloride. Ainslie does not use a flame method. So,

Ainslie does not teach or suggest anything with respect to whether flame sprayed glass particles can be doped with erbium or other rare earth metals.

In summary, the Examiner has not made out a *prima facie* case of obviousness because the references taken as a whole cannot be combined in the manner proposed by the Examiner. There is no teaching, suggestion or motivation to make the combination proposed by the Examiner in view of the distinct differences between the methods disclosed in the references, and the specific teachings (particularly in Hawtof) that would direct skilled persons away from making such combination. Second, even if the combination were attempted, the invention as claimed would not result. None of the references show a flame hydrolysis method in which a second glass component that includes a rare earth metal is introduced in atomized liquid form through a second tube passing through the same nozzle as the fuel gas to a flame. This method step in combination with the other method steps of the pending claims represents an advance in producing homogeneous multicomponent glass particles.

Claims 37 to 45 distinguish over the art and should be allowed.

***Rejection of claims 46-52 based on of Randall, Hawtof, Ainslie, Takahashi and Finnish Patent 98832***

Applicants respectfully request reconsideration and withdrawal of the rejection of claims 46-52 under 35 U.S.C. §103(a) as being unpatentable over Randall in view of Hawtof, Ainslie, Takahashi and Finnish patent 98832 (FI '832).

The Examiner stated that claims 46-52 are substantially the same as claims 37-45, except that claims 46-52 require that a fuel gas be used to cause atomizing of the second glass component. The Examiner asserted that FI '832 discloses the use of fuel gas as an atomizing gas.

FI '832 does teach that a fuel gas may be used as an atomizing gas in a flame hydrolysis method. However, FI '832 does not fill the gaps in the disclosures of Randall,

Hawtof, Ainslie and Takahashi that were identified in response to the rejection of claims 37-45. FI '832 does not show a flame hydrolysis method in which a second glass component that includes a rare earth metal is introduced in atomized liquid form through the same nozzle as the fuel gas to a flame. FI '832 does not concern multicomponent glass particles. FI '832 simply does not address making homogeneous multicomponent glass particles that incorporate rare earth metals. Therefore, for the same reasons that claims 37 to 45 are allowable, claims 46-52 are allowable.

### *Conclusion*

In view of the above amendment, applicants believe the pending application is in condition for allowance.

Enclosed is a Petition for a Two-Month Extension of Time. Applicants believe no other fee is due with this response. However, if another fee is due, please charge our Deposit Account No. 22-0185, under Order No. 20386-00294-US from which the undersigned is authorized to draw.

Dated: March 18, 2008

Respectfully submitted,



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